

**ANNOTATION**  
on the dissertation work of:  
**«RESEARCH OF VEHICLE PROPELLERS AND THE  
DEVELOPMENT OF THEIR RATIONAL DESIGN ON THE EXAMPLE OF  
A WHEELCHAIR»,**

presented for the degree of Doctor of Philosophy (PhD) in specialty  
6D071300 – «Transport, transport equipment and technologies»

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**Justification of the need for this research work.** The design of a walking mover for a wheelchair, which is urgently needed by people with limited ability to move along staircases and other obstacles.

**Relevance of the theme.** This work presents the results of many years of targeted research on the problem of increasing the cross-country ability of land vehicles in off-road conditions.

Vehicles are today used to perform a wide variety of work related to human life. These are long-haul transportation of people and goods, intra-industrial and intra-city transportation, quarry transportation, transportation of various agricultural cargo, as well as vehicles are used to perform non-standard types of work related to emergency situations, special work in the defense industry and in the conditions of geological exploration. In addition, vehicles are used to transport household goods, children and disabled people along the flights of residential buildings.

**The purpose of the work.** Development of a new kinematic-constructive scheme of a walking mover for a wheelchair that can move along staircases and determination of its main parameters.

**Research tasks.** In connection with the goal in the dissertation work, the following tasks are solved:

- based on the study and analysis of the problems of traversal of wheeled cars to develop a new method of assessing the reversibility of kinematic-constructive different circuits of wheels in off-road conditions;
- develop a new kinematic-constructive circuit of a wheelchair wheel-walking device;
- develop methods for synthesis and analysis of the stroller (walking device for the stroller, allowing you to determine its basic parameters when designing;
- make a demonstration layout of a stroller with a wheel-walking device.

**The author's personal contribution:**

- to obtain an equation to calculate the energy characteristics of the moving wheel movers, with a comparative assessment of the different parameters of the movers;
- creation and application of the method of research of stepping engines in the laboratory, taking into account the physical and mechanical properties of the supporting surface.

**The following main provisions to the defense:**

- analysis of research on the problems of above-ground road less transport;

- theoretical analysis of the reversibility of wheeled and wheel-walking engines;
- Analysis of the interaction of wheel-walking engines with supporting surfaces;
- The device and the principle of the new engines for moving on the flights of stairs have been developed;
- Technical conditions for design development and feasibility studies have been developed.

**The scientific novelty of the work.** The scientific novelty of the thesis work are:

- Development of a new kinematic-constructive wheeled circuit (walking device to improve wheelchair traversal;
- based on the systematization of the principles of structural formation of standing machine schemes, a scientific and sound method of structural and metric synthesis of rational ODA structures has been developed;
- development of a method of quantifying the reversibility of wheels of different designs;
- development of a methodology for comparative analysis of wheel and wheel-walking device schemes for a wheelchair.

**The reliability of scientific results** is achieved by correct use, on the basis of mathematical modeling, of the main provisions of the theory of machines and mechanisms and experimental studies of experimental prototypes of a wheelchair with walking propellers and have been practically tested on a working model.

**Research methods.** The reliability of scientific results is achieved by correct use, on the basis of mathematical modeling, of the main provisions of the theory of machines and mechanisms and experimental studies of experimental prototypes of a wheelchair with walking propellers and have been practically tested on a working model.

**Practical significance.** The results of theoretical studies are summarized in an algorithmic form into a general methodology for determining the main parameters of a wheel-walking propulsion device for a wheelchair when designing its structure.

For a more visual representation of the designs of the proposed wheel-walking propeller, an operating model of a constructive approximation was made in the form of a wheelchair, capable of moving along staircases of buildings with maneuvering on staircases both manually and electrically.

All these materials can be used to create new walking propellers for a wheelchair to solve industrial and sociological problems.

**Testing.** The results of the dissertation work were discussed and reported at the International Scientific and Practical Conference «CONDUCT OF MODERN SCIENCE–2018» November 30-December 7, 2018r. Sheffield (England)., at the International Scientific and Practical Conference «VEDECKY PRUMYSL EVROPSKEHO KONTINENTU-2018» 22- 30 November 2018 Prague (Czech Republic)., at the International Scientific and Practical Conference «DNY VEDY-2019, March 22-31, 2019 Prague (Czech Republic)., at scientific seminars of the Department of "Transport equipment, mechanical engineering and standardization" of the Kazakh University of Railways and are recommended for the release of a textbook for students of the educational program "Transport equipment and technology" and university teachers.

**Publishing.** According to the results of the study, 22 scientific articles were published, with 13 articles in journals recommended by the authorized body, 3 in the materials of International conferences, 4 articles in the journals of the Scopus database (Scopus).

### **The contribution of the dissertation to the preparation of publications**

**1** «Mathematical and computer models in estimation of dynamic processes of vehicles». Mathematical calculations of vehicles. Selection of materials for calculation and for experiments.

**2** «Walking propellers of transportation vehicle for driving under steppe road-off conditions». Search for materials for creating a layout, mathematical processing and discussion of experimental results, design of the article.

**3** «Design of adaptive suspension for universal vehicle course.». Mastering the design of adaptive suspension for the universal running of the vehicle. Preparation of graphs and their description, design of the article.

**4** «Adaptive frame of universal vehicle course». The selection of materials for the review and its writing, the writing of the introduction, methodology and conclusion, the preparation of schedules and their description, the design of the article.

**5** "The patency of the wheel and the wheel-walking device of vehicles". Writing sections: introduction, methodology, conducting experiments and their results, design of the article.

**6** "Synthesis of mechanisms of walking musculoskeletal devices". Drawing up the outline of the article, selecting materials for the review, writing an introduction, review and conclusion.

**7** "The dynamic process that occurs when a single wheel of a vehicle collides with a frontal obstacle with a height equal to half the length of the wheel radius." Drawing up an article plan and writing sections.

**8** «Kólikterdín adymdaýshy qozgaltqyshtaryn damytý». Drawing up a plan of the report and its full preparation.

**9** "Synthesis of the walking wheel circuit". Development of the report plan, selection of materials, writing the main part with discussion of research results.

**10** "Reliability of vertical stability of the chassis of vehicles when driving on mountain - crossed roads". Selection of material and its systematization, writing of the main sections, design of the report.

**11** "Features of the installation of the adaptive suspension mechanism relative to the direction of movement depending on the design of the wheel of vehicles." Development of the report plan, selection and materials.

**12** "Dynamic process of a single vehicle mover". Search and selection of materials for the review and its writing, statistical processing of research results and their description, writing a conclusion.

**13** "Kinetostatics of the walking wheel of aboveground vehicles". Development of the plan and structure of the report, systematization of the material and writing of the main sections, design of the report.

**14** "Development of a constructive solution for an all-terrain wheelchair". Systematization of experimental data and description of research results, writing sections: methodology and discussion of results, design of the article.

15 "Theoretical foundations of reliability of mechanical systems of transport vehicles". Development of an article plan, writing a review, methodology and discussion of results, responses to reviewers' comments.

16 "Reliability of the vertical stability of the two-wheel drive of vehicles when driving on mountain-crossed roads". Writing sections: relevance, methodology and conclusion.

17 "The essence of the effect of the movement of the parallelogram body of the bridge of two-support vehicles". Development of the plan and structure of the report, systematization of the material and writing of the main sections, design of the report.

18 "Interaction scheme and operating parameters of the floating suspension mechanism of vehicle propellers". Calculation of working parameters with the interaction scheme of the floating suspension mechanism of vehicle engines.

19 About the designs of the mechanical wheel adapter of land vehicles. Collecting material about the designs of the mechanical wheel adapter of ground vehicles.

20 Interaction scheme and operating parameters of the floating suspension mechanism of vehicle propellers. Selection of materials and its writing, statistical processing of research results and their description.

21 Over ground vehicles for traffic in steppe road conditions. Collection of material, writing and registration for publication.

22 Adaptive frame of universal vehicle course. Development of the report plan, selection of materials, writing the main part with discussion of research results.

23 "Dynamic process of a single vehicle mover". Development of the plan and structure of the report, systematization of the material and writing of the main sections, design of the report.

24 "Development of a constructive solution for an all-terrain wheelchair". Development of a wheelchair layout.

25 "Theoretical foundations of reliability of mechanical systems of transport vehicles". Search for publications for the review and its writing, writing sections: research methodology, research results, design of graphs, responses to reviewers' comments.

26 "On the designs of the mechanical wheel adapter of land vehicles". Collecting material, publishing an article, drawing up a plan.

27 "Interaction scheme and operating parameters of the floating suspension mechanism of vehicle propellers". Search and selection of materials.

28 "Propellers of vehicles with universal stroke". Collecting material, publishing an article, drawing up a plan.

29 "Walking wheel for all-terrain vehicle". Development of an article plan, writing a review, methodology and discussion of results, responses to reviewers' comments.

**The structure and scope of the dissertation.** The dissertation work includes a title page, content, normative references, definitions, symbols and abbreviations, an introduction, four sections, a conclusion, a list of sources used 36 titles, annexes, contains 105 pages, 44 figures, 4 tables.

## **Conclusion**

Based on the conducted research and development and theoretical research works, the following conclusions can be drawn:

The wheels of the propellers of aboveground vehicles operating in large construction projects, road construction and emergency situations, today, do not meet the requirements of the patency of exceptionally difficult off-road conditions. Attempts to increase the patency of vehicles operating in non-standard conditions have not yet yielded concrete results.

Research work aimed at creating a design of a walking wheel type with a high degree of cross-country ability ended with the development of a design of high-passable walking wheels for slow-moving propellers inside industrial transport and for movement along staircases. These works did not give the modernization of the wheel to the end. Therefore, this work is aimed at further improving the design of the walking wheel.